and make us respected by the nations of the world. Such a prophecy may seem rash with regard to a nation which does not yet do enough physical work to support a physical journal. But we know the speed with which we advance in this country: we see cities springing up in a night, and other wonders performed at an unprecedented rate. And now we see physical laboratories being built, we see a great demand for thoroughly trained physicists, who have not shirked their mathematics, both as professors and in so-called practical life; and perhaps we have the feeling, common to all true Americans, that our country is going forward to a glorious future, when we shall lead the world in the strife for intellectual prizes as we now do in the strife for wealth.

But if this is to be so, we must not aim low. The problems of the universe cannot be solved without labor: they cannot be attacked without the proper intellectual as well as physical tools; and no physicist need expect to go far without his mathematics. No one expects a horse to win in a great and long race who has not been properly trained; and it would be folly to attempt to win with one, however pure his blood and high his pedigree, without it. The problems we solve are more difficult than any race: the highest intellect cannot hope to succeed without proper preparation. The great prizes are reserved for the greatest efforts of the greatest intellects, who have kept their mental eye bright and flesh hard by constant exercise. Apparatus can be bought with money, talents may come to us at birth; but our mental tools, our mathematics, our experimental ability, our knowledge of what others have done before us, all have to be obtained by work. The time is almost past, even in our own country, when third-rate men can find a place as teachers, because they are unfit for every thing else. We wish to see brains and learning, combined with energy and immense working-power, in the professor's chair; but, above all, we wish to see that high and chivalrous spirit which causes one to pursue his idea in spite of all difficulties, to work at the problems of nature with the approval of his own conscience, and not of men before him. Let him fit himself for the struggle with all the weapons which mathematics and the experience of those gone before him can furnish, and let him enter the arena with the fixed and stern purpose to conquer. Let him not be contented to stand back with the crowd of mediocrity, but let him press forward for a front place in the strife.

The whole universe is before us to study. The greatest labor of the greatest minds has only given us a few pearls; and yet the limitless ocean, with its hidden depths filled with diamonds and precious stones, is before us. The problem of the universe is yet unsolved, and the mystery involved in one single atom yet eludes us. The field of research only opens wider and wider as we advance, and our minds are lost in wonder and astonishment at the grandeur and beauty unfolded before us. Shall we help in this grand work, or not? Shall our country do its share, or shall it still live in the almshouse of the world?

PAPERS READ BEFORE SECTION B.

Determination of the relation between the imperial yard and the metre of the archives.

BY WILLIAM A. ROGERS OF CAMBRIDGE, MASS.

This paper was a continuation of one upon the same subject presented at the Montreal meeting. The mean result of the determinations up to that time was as follows: Imperial yard + 3.37015 inches = Metre des archives.

The writer stated at that time, that he should not like to be held to a very strict account with regard to the last decimal figure, or even the last two decimal figures, on account of the difficulty of obtaining the requisite data.

Since the meeting last year, additional data have been obtained. In February of the present year, a combined yard and metre was received from Paris. The yard was compared with the imperial yard, in 1880, by Mr. Chaney, the warden of the imperial standards. During the interval between 1880 and February of the present year, this metre has received repeated comparisons with the metre of the International bureau, under the direction of Dr. Pernet. According to his report, this metre is 310 mikrons too short at 0° centigrade; for the same temperature, the yard was found by Mr. Chaney to be 20.7 mikrons too short.

Comparing the metre and the yard upon this bar with the bronze yard and metre described at Montreal, and combining the results with those previously found, the relation was found as follows: Imperial yard + 3.37039 inches = Metre des archives.

The magnetophone, or the modification of the magnetic field by the rotation of a perforated metallic disk.[1]

BY PROF. H. S. CARHART OF EVANSTON, ILL.

The experiments of Bell, Preece, and others, on the radiaphone, suggested the possibility of interrupting, or at least periodically modifying, the lines of force proceeding from the poles of a magnet, by means of a disk of sheet-iron, perforated with a series of equidistant holes, and rotated so that the holes should pass directly in front of the magnetic pole. It is well known that the armature placed on the poles of a permanent magnet diminishes the strength of the external field of force by furnishing superior facilities for the formation of polarized chains of particles from pole to pole. This is the case even when the armature does not touch the poles, but is in close proximity to them.

If a piece of sheet-iron be placed over the poles of a magnet without touching, and magnetic curves be developed on paper above the iron, they will be found to exhibit less intense and less sharply defined magnetic action than when the sheet-iron is removed. If, however, a small hole be drilled directly over each magnetic pole, the screening action of the sheet-iron is modified in much the same way as when a hole is

[1] This paper will shortly be published in SCIENCE in full.

made in a screen opaque to light; for the developed curves show distinctly the outline of the holes. If, therefore, the sheet-iron in the form of a circular plate, pierced with a number of holes, be rapidly rotated between the poles of a magnet and small induction bobbins, the action of the magnet on the core of the bobbins will be periodically modified, because of the passing holes: and hence induced currents will flow through a circuit including the bobbin. A disk of sheet iron was pierced with two circles of quarter-inch holes concentric with the disk, the number of holes in the two circles being thirty-two and sixty-four respectively. On one side of the disk was placed a horseshoe magnet with its poles very near the rows of holes; on the other side were arranged two corresponding induction bobbins. The circuit was completed through a telephone and either bobbin at pleasure. Upon rotating the disk rapidly, a clear musical sound was produced in the telephone, the pitch rising with the rapidity of rotation. Moreover, the bobbin opposite the circle of sixty-four holes gave the octave above the other, and each gave a note of the same pitch as was produced by blowing a stream of air through the corresponding holes.

Magnetic survey of Missouri.

BY F. E. NIPHER OF ST. LOUIS, MO.

IN the spring of 1878 a survey of Missouri was begun, which was expected to determine all points in regard to terrestrial magnetism: 160 points have been covered. The work was undertaken under private auspices, most of the money tendered unasked, and the work has been carried on successfully until the present time. The first three years were spent in making a preliminary survey. In the early part of the survey we labored under great difficulties, because I supposed that the lines of equal value, laid down upon the observations given in the coast-survey charts, were substantially correct; so that time was frequently lost in repeating values at stations left behind, in order to be certain that no error had been committed. But when we settled down to the conclusion that we really knew nothing about the matter, we had very much less trouble. At first, intensity determinations were made at each station; but in later years, since the magnets have proved so satisfactory, the plan was adopted of making absolute determinations only at regular intervals during the summer. The temperature corrections for the magnet were made twice, — once in 1878, and once two years ago, — and they agreed very closely with each other.

The dip circle was a large one, such as was formerly much used, and which was found to be an excellent instrument, though rather clumsy to carry. The charts which have been prepared show what the results were. In a former communication to the association at Cincinnati, I suggested an explanation of the peculiar flexures of the isogonic lines, as being due to earth-currents which seemed to be deflected by the moist river-valleys. The map upon which that hypothesis was based represented observations taken over the entire state. By re-determination we have found that those observations were all correct; but more detailed work shows that this explanation is not admissible. There is no explanation of the fact that contour has any thing to do with the deviation of the needle from the normal values. Similar flexures are also seen in the lines of equal inclination and the lines of intensity. One and perhaps two years will be required to accomplish the work properly. There is nothing new in the subject, except the rather unexpected flexures which we found in these lines. It shows very clearly that the isogonic lines which are published for the use of surveyors are of no earthly use. Work ought to be done in a detailed way over the whole country; and I hope we shall some time be able to combine with these determinations a series of magnetic values at ten or twelve different stations in the state of Missouri, and also simultaneous determinations of earth-currents upon lines making angles with each other at the different stations. Similar variations would probably be found in the states of Illinois and Iowa.

In the discussion which followed, President Rowland said, that with respect to the earth-currents, he himself never saw any experiments which gave steady earth-currents. Earth-currents are usually supposed to vary very quickly. They do not pass in a steady direction anywhere; and therefore he would inquire whether Professor Nipher has any reason to suppose there are such earth-currents, and, further, whether these local changes of these lines may not be due to hidden mines of iron, or something or other, rather than to earth-currents.

The question was also asked, whether, in comparing earlier observations with the later, there are variations from year to year which would soon invalidate any survey that could be made, and render it comparatively of no value.

I suppose, replied Professor Nipher, that, over rather large areas of country, the annual change does not vary very rapidly in space. In the western states, so far as I know at present, it is pretty nearly constant, though I do not know as we have any reason to say that it is really constant. Replying to the president's last question, I should say that the determination to which I have referred, as regards earth-currents, was not for the purpose of testing the theory which I formerly had, but simply for the purpose of examining a cause which certainly has some effect. I think it is well enough known that it is a fact, and it is well to investigate it, since we found so many unexpected things. I should suppose that the explanation, that it is due to magnetic matter under the surface of the earth, is the much more probable one, as the case stands now. As to the disposition of that magnetic matter, you can make a great variety out of that, and locate your mines in various parts of the state.

Prof. A. E. Dolbear inquired whether any investigations have been made as to the direction of earth-currents; and whether Professor Nipher knew of any device which would enable him to detect the

direction of them in any place. He had made some observations on a line of his own, half a mile long, and had invariably found that in that line the current is in one direction; and its electro-motive force varies from about one-tenth of a volt up to three volts.

In regard to these lines, said President Rowland, quick flexures of that sort must be due to local causes. They cannot be due to any thing at the centre of the earth. With respect to using a line in determining earth-currents, I think it is unsatisfactory. I do not believe very much in it, myself. You can get a current in the line, but you are not certain it is in the earth.

A member remarked that in 1881, in Boone County, Missouri, he had a line in which a continuous current was evinced with an electro-motive force of from two to four volts. From 8 to 10 in the morning was the maximum, and 5 P.M. the minimum. The line being east and west, the direction of the current was from east to west.

President Rowland said: If you put the wire on the earth's surface from one point to another, you merely determine the difference of intensity between those points. It shows there is a current there when the wire is there, but not when the wire is not there.

A method of distributing weather forecasts by means of railways.

BY T. C. MENDENHALL OF COLUMBUS, OHIO.

THIS system has only been in operation in Ohio for about a year. To distribute forecasts, we place signals upon the sides of the baggage-cars, as distinct as possible from each other, so as to be easily recognized at considerable distances, and also to convey as much meaning as possible, so as to predict as many different conditions. We adopted a combination of form and color. The signals are three in number as to form, and two in number as to color. The red signals are confined to predictions as to temperature, — rise in temperature, stationary temperature, falling temperature. The other color is blue, and that is confined to predictions in regard to the general state of the weather. The question of form was a good deal considered, and three forms were adopted. We adopted the sun, moon, and star, because everybody was familiar with those words. We experimented with the triangle, and finally rejected it. The device for attaching to the car is due to Mr. Anderson, who has been in the service of the board of commissioners for the past year; and it is a really happy device. The signal is made as large as possible, and the disk can be seen a long distance. The red sun and blue moon mean higher temperature and general rain. The crescent means lower temperature; the full disk of blue means general rain; the star represents local rains. With regard to the proper working of the system, though it has been in operation but a short time, it has really done good work. We receive special telegrams every morning, and they are transmitted to the train-despatchers at five o'clock. We are as yet operating it only on one railroad. It happens, fortunately, that that road goes through an agricultural region of considerable importance. It is the road connecting the cities of Columbus and Cleveland. Two trains start out in the morning, at the middle point between those cities. The signals are put on the cars at five o'clock in the morning; and as they run through the morning hours, the farmers along the line can have an opportunity of seeing them, and predicting the weather for the day. The railway company circulated through the whole line little cards, having these signals displayed in colors, with their meaning in every combination. This helps us, because it enables everybody to understand what is meant. A recent communication from Gen. Hazen indicates a disposition on the part of the general government to take hold of the matter, and bring it into general operation as far as possible. Postal-cards have been sent to various persons along the line, with questions in regard to the practical working of the system, which are answered and sent in at the end of every week; and we find, that, on the average, 80 per cent of the predictions are verified.

Plan for a state weather service.

BY F. E. NIPHER OF ST. LOUIS, MO.

WHILE a good many are accommodated by the weather-signals which Professor Mendenhall has already inaugurated, many live a distance from the railroad, and cannot be interested in a scheme which makes it necessary to travel eight or ten miles to learn about the weather, because they might be interested in a different kind of weather by the time they got home. The information might be most easily circulated by telegraphing from picket-stations to the westward. There might be a line of stations on the railroad north and south; and stations might be found necessary in Nebraska, which would give immediate warning to the central office whenever it began to rain at the station; and a code might be arranged, so as to give the idea of the operator as to the probable violence or duration of the rain. Of course it would be necessary to make special study of the general laws for the progress of summer rains. Supposing the information is telegraphed to the central station, the predictions can easily be made out as soon as the picket-stations could be reached, and a clear idea obtained as to the probable direction of the storm, and the time at which it would reach the different portions of the state. That information could be transmitted by the railway companies. Finally, we should make more intimate connection between these and private telegraph-lines which can be constructed by the persons who are to be served with the weather-signals. This plan contemplates the erection of private telegraph-lines leading in from the country to the stations. Upon a twenty-mile line, which would be a frequent length in Missouri, ten farmers will have to pay for the erection of a couple of miles of wire, and the instruments, which can be put up for $30 a mile. Some person could be sent from the vicinity to the director of the service, and instructions given him in regard to the manner of operating the

line and the management of the batteries. The cost of the line, therefore, to each farmer, would be, say, $75, which might be distributed over ten years. Mr. Nipher stated that in several localities the farmers will undertake it just as soon as the information can be furnished them. At the stations the lines could easily be made to terminate in the store of some merchant, who is anxious to secure the trade of the people on the line. This can be done at once in Missouri. The only thing necessary is for the state to appropriate a small amount of money to supply the persons and instruments for observations, rain-gauges, etc. The two things necessary to make it successful are information as to rainfall, and time of beginning and ending of rains.

NOTES AND NEWS.

— The next meeting of the American association for the advancement of science will be held in Philadelphia, probably during the first week in September, 1884. At the session in Minneapolis last Tuesday, the following persons were chosen as officers for the Philadelphia meeting: President: Dr. J. P. Lesley, of Philadelphia. Vice-presidents: Section A (mathematics and astronomy), Prof. H. T. Eddy, of Cincinnati; B (physics), Professor John Trowbridge, of Cambridge; C (chemistry), Prof. J. W. Langley, of Ann Arbor; D (mechanical science), Prof. R. H. Thurston, of Hoboken; E (geology and geography), Prof. N. H. Winchell, of Minneapolis; F (biology), Prof. E. D. Cope, of Philadelphia; G (histology and microscopy), Prof. T. G. Wormley, of Philadelphia; H (anthropology), Prof. E. S. Morse, of Salem; I (economic science and statistics), Hon. John Eaton, of Washington. Permanent secretary: Mr. F. W. Putnam, of Cambridge. General secretary: Dr. Alfred Springer, of Cincinnati. Assistant general secretary: Prof. E. S. Holden, of Madison. Secretaries of the sections: A, Mr. G. W. Hough, of Chicago; B, Mr. N. D. C. Hodges, of Salem; C, Prof. R. B. Warder, of Cincinnati; D, Prof. J. B. Webb, of Ithaca; E, Prof. E. A. Smith, of Tuscaloosa; F, Prof. C. E. Bessey, of Ames; G, Dr. Romyn Hitchcock, of New York; H, Mr. W. H. Holmes, of Washington; I, Mr. Charles W. Smiley, of Washington. Treasurer: Hon. William Lilly, of Mauch Chunk.

— A course of eighteen special lectures will be given next year to members of Johns Hopkins university on topics relating to instruction in the higher institutions of learning. They will be informal lectures, connected only by the general purpose of helping advanced students who are looking forward more or less definitely to the work of teachers to become familiar with the principles and methods followed by other persons, and with the results which have been obtained in different types of educational establishments. The following are announced: —

The present state of university and collegiate instruction in this country, by D. C. Gilman; Recent observations on educational foundations in Europe, by D. C. Gilman; Natural and ethnic history of arithmetic, by J. J. Sylvester; The educational value of grammar, by B. L. Gildersleeve; The future sphere of classical philology, by B. L. Gildersleeve; Educational value of the study of chemistry, by Ira Remsen; What to teach in biology, by H. Newell Martin; One lecture by H. A. Rowland; The observational element in mathematics, by C. S. Peirce; The *a priori* element in physics, by C. S. Peirce; The *naïve* in education, by H. Wood; Modern methods in the study of history, by H. B. Adams; Methods of comparative philology as pursued to-day, by M. Bloomfield; The new impetus given to the study of Latin by the application of the historical method, and by the study of inscriptions, by Minton Warren; Hygiene in collegiate training, by E. M. Hartwell; Rhythm and education, by G. Stanley Hall; The educational value of specialization and original work, by G. Stanley Hall; The uses of libraries in education, by D. C. Gilman.

A course of nine lectures specially designed for college students will also be given, as follows: —

The choice of a profession, by D. C. Gilman; The light which biography throws on college life, by D. C. Gilman; Reading as an auxiliary to study, by W. Hand Browne; The right use of translations, by C. D. Morris; Historical fiction, by H. B. Adams; The English universities, by J. Rendel Harris; Recreation, by E. M. Hartwell; Mental hygiene, by G. Stanley Hall; Science work, by Ira Remsen.

— The Imperial meteorological observatory of Japan has established a telegraphic weather-service, and at present receives reports from twenty-two well-distributed stations. No forecasts are yet attempted, although it is the intention to make them as soon as sufficient experience will justify the step. Tri-daily maps and bulletins are, however, prepared. It is interesting to note that but one telegram is received each day from the several stations. This is sent by the aid of a cipher, which consists of a simple combination of figures, not of words, as is the case in the cipher used by the U. S. signal-service. The daily despatch is the equivalent of about eight words, and contains all the usual meteorological data for each of the three preceding observations.

— The Meteorological council publishes the results of rainfall observations at three hundred and thirty-six stations in Great Britain, made without interruption from 1866 to 1880, under the supervision of Mr. G. J. Symons. The monthly means are given for each year, for each period of five years, and for the whole fifteen years. No discussion of the observations is made, though it would seem that valuable conclusions could be derived from them.

— Mr. V. T. Chambers, an entomologist well known for his studies on the Tineina, died at his residence in Covington, Ky., at two o'clock on the morning of Aug. 7. During the afternoon of Aug. 6 he had a stroke of paralysis, and died from its effects. He was fifty-two years old on that morning. He was a constant contributor to the *Canadian entomologist* and many other entomological journals. In the Bulletin of the U. S. geological survey there are several papers from his pen: viz., the Tineina of Colorado; notes on a collection of tineid moths made in Colo-